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Published in:
International Journal of Industrial Engineering and Management

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

International Journal of Industrial Engineering and Management (IJIEM), Vol.5 No 4, 2014, pp. 195 - 206
Available online at www.ftn.uns.ac.rs/ijiem
ISSN 2217-2661

UDK: 658.523

Managing Variety in Configure-to-Order Products - An Operational Method -

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Received (25.08.2014.); Revised (19.10.2014.); Accepted (20.11.2014.)

Abstract

Companies producing customized products tend to increase the variety of their product portfolio, in order to fulfill the demand of their customers and align their strategies with those of competitors. However, the profitability of product families may vary greatly. The purpose of this paper is to develop an operational method to analyze profitability of Configure-To-Order (CTO) products. The operational method consists of a four-step: analysis of product assortment, profitability analysis on configured products, market and competitor analysis and, product assortment scenarios analysis. The proposed operational method is firstly developed based on both available literature and practitioners experience and subsequently tested on a company that produces CTO products. The results from this application are further discussed and opportunities for further research identified.

Key words: *Configure-To-Order products, operational method, product variety, profitability analysis*

1. INTRODUCTION

The latest tendency in many manufacturing companies is to increase the number of different products they offer to their customers, in order to better satisfy requirements and target new customer segments. Unfortunately, the increment of product variety tends to negatively affect operational performance.

Mass customization has been proposed as an overall approach to offer product variety without penalizing operational performance [1] [2] [3]. However, in order to sustain a competitive price a mass customizer has to keep under control its offering variety [4]. This product variety limitation restricts the need for increasing the information-processing capacity and/or reduces its information-processing requirements thus limiting costs [5]. Therefore, a company that embraces a mass customization approach in order to overcome the trade-off between product variety and operational performance has to decide how to limit its product variety.

One context in which mass customization is adopted is that one of the Configure-To-Order (CTO) operations [1]. When producing CTO products, a desired level of product differentiation can be achieved, as many of the variable parameters can be configured in order to fulfill specific customer requirements. On the other hand, this parameter differentiation enables the production of a vast number of variants, and not all of them contribute positively to a company's profit. As a result, a profitability analysis is of high importance in CTO environments. Several researchers have been working on identifying the value adding product attributes that when differentiated, offer the required variants [6] [7] [8] [9].

To this end, the need of managing product variety has become imperative and several approaches have been applied [10] [11] [12] [13]. However, there is a lack of a structured operational method that incorporates the issues of product profitability and variety in Mass customization and more specifically in CTO environments, in a level of detail that could be of use to both researchers and practitioners. The purpose of this research is to create such an operational method, a detailed approach to how CTO manufactures should deal with product assortment issues, from a strategic point of view. For this reason, several drivers have to be taken into consideration, such as product profitability, customer preferences, and competitive products on the market.

The rest of the paper is structured as follows. Section 2, the literature review, identifies and discusses the existing approaches to profitability analysis studies and the management of product assortment. In section 3, the research operational method is argued. In section 4, the suggested approach is presented, and, then, in section 5, it is tested on a company. Finally, in section 6, conclusions and issues for further investigation are discussed.

2. LITERATURE REVIEW

The literature review is focused on two main research areas, product management and profitability analysis. Nevertheless, early in the review process, it is realized that these two fields are highly interconnected. As discussed in the previous section, due to the nature of CTO products being easily and slightly differentiated, manufacturers should be able to distinguish between the variants that are profitable for a company and determine to what extent they are profitable. For this purpose, the literature review focuses on identifying and discussing the different existing approaches for performing a profitability analysis and determining how the outcome can be used to develop a strategy for managing the product portfolio. In order to gain a deeper understanding and be able to perform a critical literature review, the approaches for profitability analysis are presented first, and, then, the different suggestions for management of a product portfolio are presented.

The literature search has been performed in online libraries by using keywords such as "product assortment", "profitability analysis", "product management" and "product planning". Additionally, the list of references of each article is used to identify related bibliography, as well as the names of the researchers in the recognized research groups within this field. As the content of this research lies also in complexity management, the research group has used sources from an extended literature study performed in this field. The critical literature review is not only used for deeper understanding of the so far developed approaches, but it is also part of the interpretative philosophical position in the chosen operational method [14].

2.1 Profitability analysis

Hansen et al. [15] perform an ABC analysis of product profitability by calculating the contribution margin and net revenue of each variant, and then making the ABC classification by using the Pareto Law [16].

To a broader extent, Wearden [17] lists the main factors that have to be included in a performance analysis. Turnover, profit and ratios, sales records, capital utilization and overheads are among them.

Wheeldon [18] discusses the different aspects that have to be taken into consideration when identifying a product policy. He makes an initial step in connecting the market-oriented factors that influence the profitability of the products and factors that should be considered in developing a product strategy. The local market where a company operates, the international markets of current or future operation and the technological status of both a company's own products and of those offered by competitors are subjected to further analysis. This will provide the company with a valid perspective regarding its position in the market.

In addition, different methods have also been used by several researchers regarding product profitability, such as mathematical modeling and heuristics. Dobson and Kalish [19] create a mathematical program to quantify the profit of a company, taking into account product desirability and fixed and variable costs. Additionally, the suggested operational method can also include, apart from a company's own products, similar competitive products. A more customer-oriented ABC analysis is introduced by Juran [20] based on the Pareto Law, and is discussed by Liiv [21] [22], using demand association in order to improve product classification.

These publications have been looking merely into the profitability analysis of products in terms of identifying factors and methods. The rest of the literature review discusses the existing research on portfolio management. However, it also highlights the interconnection between these two areas.

2.2 Portfolio management

By performing a critical literature review, it is realized that portfolio management is highly related to profitability analysis.

Starting from a more general approach, is to point out the need of diversity inputs when developing a product strategy. Muneer and Sharma [23] conclude that production planning, product development, and sales are these aspects.

Flapper et al. [24] discuss two strategies regarding product assortment. The first strategy investigates the contribution of each product to the total net profit, while the second strategy has the same approach but for customers. Two mathematical models are developed for determining the optimal product and customer based assortment.

A similar approach is also discussed by Wheeldon [18]. He suggests that short-term solutions should be oriented towards existing customers when defining a new product range. A framework for evaluation of a product line design is introduced by Li and Azarm [25]. The framework includes factors that affect the evaluation, such as commonality of variants, customer preferences, competitors and business goals. In other words, the framework suggests an internal and external analysis of a company.

The identification of the optimal set of products for a company so as to maximize its value, is also discussed by Gonzalez et al. [26]. Value is realized as the sum of benefits of a set of products minus all costs created throughout product lifecycle activities. This definition of value, and more specifically of the benefits and costs, differs slightly from the economic values used in the ABC classification suggested by Hansen et al. [15].

From a different perspective, De Reyck et al. [27] assess the relation between portfolio management and information technology projects, and identify portfolio performance as one of the objectives. The suggested operational method for financial analysis includes the calculation of return on investment (ROI), internal rate of return (IRR), net present value (NPV) and economical value added (EVA). Similar approaches have been suggested by Benaroch [28] and McGrath and Macmillan [29]. Financial analysis could also be seen as a part of profitability analysis.

A framework for examining the decisions regarding a company's product variety is presented by Kamalini [2].

The number of products, the targeting markets, and the time for each product to be introduced are identified as the key drivers of variety creation. Its implementation is related to a company's resources and capabilities.

To sum up, the previously discussed literature may vary in terms of methodology and scope. However, this review reveals that there is a common ground to the different approaches regarding portfolio management and product strategy. It has been identified that profitability analysis may be expressed differently, but it is a part of the development of a product strategy. In addition to that, several factors that are taken into consideration in portfolio management have been presented. Sales, customers and competitors are the factors that are met more frequently in the literature. However, in the literature studied no examples were found regarding how to assess the profitability of configurable products including technical assessment of product features, profitability, market aspects, competitors and an internal cost profile.

3. RESEARCH METHOD

The suggested operational method has been built by taking from both the existing literature and some experiences of practitioners. More specifically, the approaches in the field of product management, product planning, and product's profitability have been the starting point for developing the suggested operational method. The operational method is also based on experiences from industry, not only of the members of the research team but also of experts.

The developed operational method has been applied in an actual company. The main aim of this case study has been to test the suggested operational method and receive feedback from the managers in the company. With regards to internal validity, the research team has full access to detailed data from the company. In order to gather accurate quantitative data, un- and semi-structured interviews are performed with the "key" informants. Another benefit for the research group in order to perform this study case is the discussions with the managers throughout the whole period. The managers' expertise was valuable for the analysis performed and for their reflections on the results. The research group had semi-structured interviews with the managers, involved in this project, in order to assess the results and receive feedback. The received feedback is valuable for the verification of the operational method and for further improvements.

4. OPERATIONAL METHOD FOR MANAGING PRODUCT VARIETY

Based on the literature review, an operational method for developing a strategy for product assortment in CTO companies is developed. The suggested framework builds upon the related research fields and attempts to include all aspects that should be taken into consideration in order to develop a strategy for managing product variety.

It consists of four main phases, which have been suggested by product planning literature. The first step is scoping and defining the focus of the products to include in the analysis. The second step is an internal analysis, which is mainly inspired by literature on profitability analysis [15] [30]. The third step is an external analysis, as suggested from the product planning literature. The core idea suggests an analysis of competitors' and their products in order to place the company under investigation in its market position. The final step is a synthesis. Based on the results from the internal and external analysis, suggestions are made for future development. The four steps of the operational method are briefly presented in the following figure and further described in the following sections.

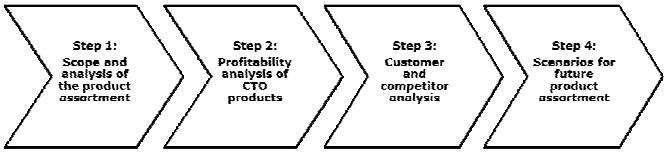

Figure 1. Operational method for managing product variety

4.1 Scope and analysis of the product assortment

The suggested operational method has as its starting point the definition of scoping within a project. Firstly, it has to be clarified which products and/or product families are to be included in the analysis. Based on experience and the literature review on case studies within this area, the main indications for a product to be included in the analysis are low profitability and a decrease in sales volume. These two factors usually signal a need for action and further examination.

Additionally, since the focus is on CTO products, an overview of the technical characteristics of the products is performed. This overview enables better understanding of the product range in terms of structures, components, dimensions, applications, sales price, cost prices etc. The Product Variant Master (PVM) technique is used at this stage to analyze the product structure, including component features, assemblies, and main attributes [1] [31]. An in-depth PVM model gathers almost all data required for the following steps of the discussed framework. Data for this step are to be collected from the designs of the products and the company's internal database, such as Product Lifecycle Management (PLM) [32] and Enterprise Resource Planning (ERP). Un- and semi-structured interviews with persons involved in each project are performed to supplement the accuracy of the findings.

4.2 Profitability analysis of CTO products

Once the analysis of product assortment is performed, the next step refers to the analysis of profitability. Data collection includes sales numbers, cost price, and sales price, which are provided by the company's database [27]. Regarding cost price, it is of great importance to ensure how it is calculated. The most common approach describes that cost price includes material cost and production cost. Additional factors that might add up to the production cost are, as identified from the

existing literature, engineering, labor, machinery and inventory costs [33].
Furthermore, an aspect that has to be taken into consideration while performing a product profitability analysis is whether the product is sold as an individual unit or as a sub-assembly. Spare parts are also to be examined separately.
The next task of the second step is to calculate the contribution margins of product assortment. Contribution margin is calculated as follows, sales price minus production cost [34]. As mentioned above and for this case study, production cost includes material and direct labor costs. In some cases it is relevant to include indirect production costs, which could be tools, machines, the rent of a warehouse, and white-collar wages.
Then, a contribution ratio is calculated as the percentage of the contribution margin of revenue. This calculation has to be made on a product- and on a product family- level. The results from this analysis reveal dependencies among the different aspects of the product assortment, indicate the most profitable products, and separate those that contribute on a lower level to the benefits.

4.3 **Market, customer and competitor analysis**

Step 3 is the analysis of the market, focusing on customers and competitors, in order to understand the placement of products in the market. To perform the customer analysis, information can be gathered on several levels, such as on the level of specific companies, industrial sectors or countries. Data related to customers include sales number, discount policies, and the exact variants that each customer purchases. The last variable is used to define the possible linked revenue of each product. The outcome of this analysis is the classification of the customers and the identification of the interdependencies among the customers and the product assortment [35].
The second phase of step 3 continues with the analysis of competitors [36]. At first, the competing companies have to be identified, and the products they are offering have to be described in a similar way as for the under examination products. This enables a comparison on valid terms. The PVM technique is also suggested at this phase for competitive products. The required level of detail is not as high as it is for the analysis of a company's own products. This is because the prior interest at this point is to make a comparison among the characteristics that have been identified as main "strengths" and/or "weaknesses" of the own product assortment and of the competitive products. It is realized that due to confidentiality and competitive issues, it is not possible to gather the same amount of information for competitive products. Sales prices and technical characteristics that can be obtained from sales catalogues are of main interest.
An overall conclusion can be drawn by calculating the relative market share for the competitors and the company.

4.4 **Scenarios for future product assortment**

The final step of the suggested operational method refers to the development of scenarios for a future optimized product assortment [37] [38]. Scenario creation is based upon the outcomes and conclusions of the previous three steps of the analysis.
The scenarios may vary from case to case; however, they are developed based on two main concepts as identified from the literature review namely variety reduction and changes in production flow.
The first scenario refers to decreasing the number of variants [39]. One way that this solution can be implemented is by eliminating the less profitable variants, which have been identified from the second step in the analysis of the profitability of the product assortment [40]; linked revenue and product substitution have to be taken into consideration in the analysis of this scenario. Moreover, the re-designing of specific components, or even products, is another option, which decreases product complexity and manages to maintain the existing variety offered to customers. Re-engineering costs have to be calculated, and the effect of the redesigned products, in terms of materials, dimensions and production process has to be measured based on related aspects, such as freight, inventory and production costs.
Another way of implementing this concept is by complete elimination of the product assortment. This scenario is considered as a drastic solution as it suggests a complete stop of production, in cases where the previous two scenarios do not offer enough benefits to invert the situation of poor performing products. Substitution of obsolete products and linked revenue has to be scrutinized.
The second scenario includes changes in the production flow. Investment in new machinery or new production sequences are the most common suggestions [2] [41]. All the related costs have to be estimated, as well as the depreciation period of any investment.
The final step is completed by an evaluation of the suggested scenarios and the final decision is taken after the comparison of the assessed scenarios that points out the most suitable solution for the development of the future strategy for product assortment.
The suggested operational method discussed in this section is applied to a case study. The description of the case and the results are presented in the following section.

5. CASE STUDY

For the application of the proposed method a CTO company in the heating and ventilation industry is chosen. The company has been operating for approximately 45 years within a global network of more than 40 countries, and its products are designed and produced in Denmark. It employees around 550 persons, and it has an annual turnover of 750 million Danish kroners. In recent years, the company has been facing a decreasing number of sales in the main

product family of its portfolio along with declining revenue.
All data used for the analysis and calculations were acquired from the electronic database of the company.

5.1 **Analysis of product assortment**

In the company, the profitability of several groups of products has been discussed for years. In order to focus on and delimit the analysis work, only one of these product groups has been selected. The criteria for selecting this specific group of products is that the overall profitability seems very low and the amount of products in the scope can be analyzed with a reasonable use of resources (in this case, two students working full time for four months and approx. 200 internal hours used by the company). Finally for these products, the company had the data needed for the analysis.
In order to define the scope of this analysis, the research team, along with the managers of the company, first has to consider which products, out of the whole portfolio require further investigation. The examined product family has been characterized by a declining number of sales for the last several years. At this point, the company is considering its options in terms of whether there is profit in maintaining the production or whether discarding the whole family from the product portfolio is a more viable solution.
The product family consists of three products, A, B and C. Product A has the largest size of all, and it is the second most beneficial in terms of net revenue. The market for A is mainly the food industry. Product B contributes the most to net revenue, it has the smallest size and its market is within the industrial sector. Product C is the newest addition to the product portfolio of the company. It has a medium size and low contribution to net revenue. Due to the difference in the material of product C in comparison to A and B, the marine sector is its main market.
The PVM technique is used to a gain technical overview of the product structures and their components.

5.2 **Profitability analysis of configured products**

The first step in the analysis of the profitability of the three products is the annual sales numbers. Data are acquired from the ERP system of the company referring to the last six years. 4.434 orders have been placed for the product family, which resulted in 7.090 units sold. In details, for product A 714 units have been sold and for B 4.912 and for C 1.464.
From the following sales figures, variants that are used as parts of other solutions are excluded; this is due to the fact that the sales price is not registered for each part used but only for the final solution.
The variants taken into account had to meet three criteria: every order has to have an active expected cost price, actual cost price and sales price, in order to have coherency among the data analyzed.

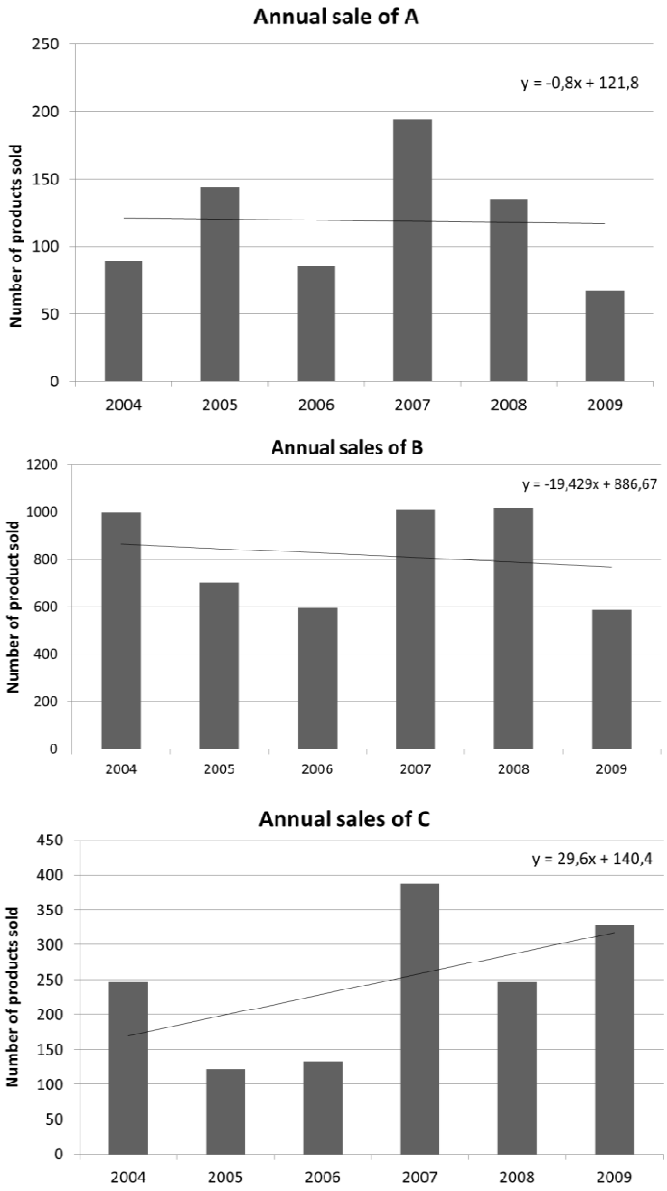

Figure 2. Annual sales of products A,B,C

Data provided by the company include:

- the transaction dates of sales provided in the format month/year, project number
- sale price
- number of units sold
- actual cost
- expected cost
- description of sales
- sale type, indicating if the transaction is a single piece sale or part of other solutions
- country where the sale is carried out.

Spare parts are also excluded from the analysis as there is lack of information about their exact size and the sales country. An analysis is made for each product. The difference between the sale price and the cost price provides the basic contribution margin.
The expected cost price originates from the company's product configurator and is based on bills of material calculation and the cost of labor in the production. The actual cost price comes from the post-calculation at the end of production and includes the same parameters

that are used in the previous calculation. The ratio between these two figures gives an indication of whether the configurator is miscalculating a given order or whether there has been some kind of problem in the production.
By performing a Grubb test for the outliers, it is concluded that orders within the range of 65 % and 135 % of the expected cost price are acceptable. The Grubb test detects the outliers and then it expunges them from the dataset. This allows a valid statistical analysis [42].

5.2.1 *Contribution margin calculation*

The contribution margin is calculated as the difference between the sales price and the production cost of each product. Then, the contribution margin is allocated on every different variant. The analysis is made on a product family level and also on an A, B, C product and variant level.
The results indicate that the average contribution ratio for product A is 38,6%. The revenue of product A accounts for 48,1% of the total revenue of the product family and for 44,7% of the total contribution margin. The analysis also reveals that 88,3% of the total revenue comes from 50% of the product range. This raises questions regarding a reduction in the number of variants offered.

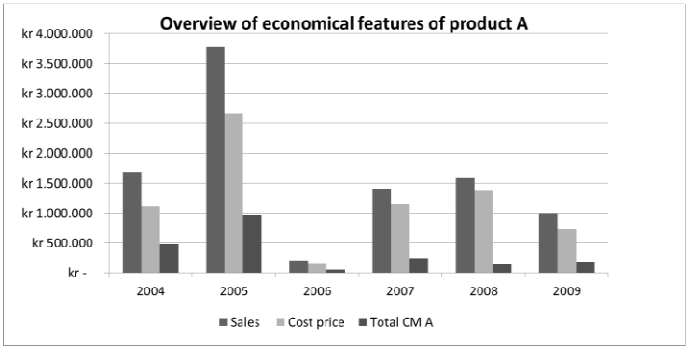

Figure 3. Overview of economical features of product A

Product B, with contribution ratio 48%, is the most profitable product within the family. It also accounts for 35% of the total revenue, 66% of the unit sales and 38,5% of the contribution margin. The analysis, furthermore, reveals that one variant accounts for 25% of the contribution ratio and the number of sales.

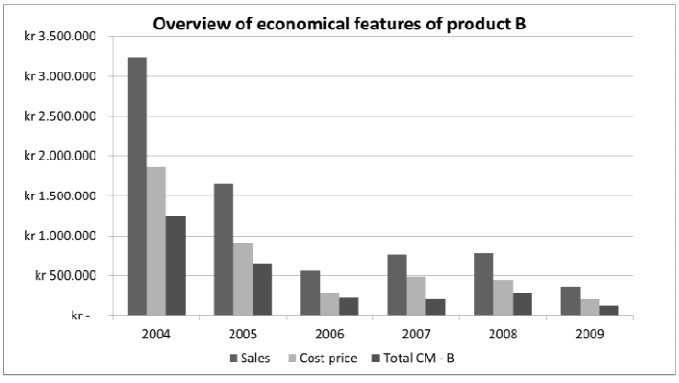

Figure 4. Overview of economical features of product B

The contribution ratio for product C is 37%, which accounts for 18,7% of the total revenue for the product family and only contributes 16,7% of the total contribution margin for the product family. Four variants are responsible for 82% of the revenue. Moreover, the newly introduced product C is not performing according to what was expected from the company, in spite of the fact that it applies the latest technology in product development and strong marketing techniques, which are expected to lead to a significant market share.

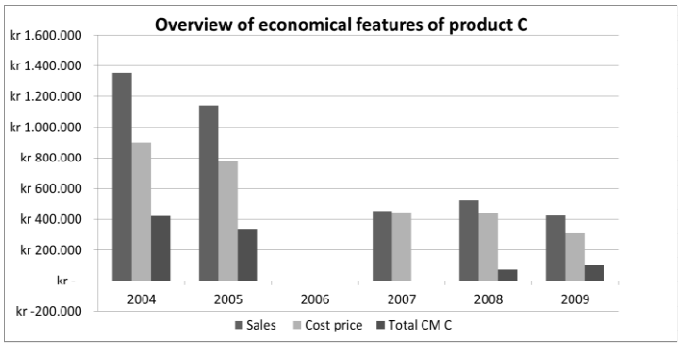

Figure 5. Overview of economical features of product C

Based on the individual sales analysis of each product, the comparison reveals that the most profitable variant identified, is clearly product B.

5.2.2 Engineering Cost

When engineering hours are used, the contribution margin is directly affected because the customer is not charged directly for engineering hours used on a project. The overall cost of engineering from 2004–2009 is 851.877 DKK for known sales. As sales vary through the years, the total cost of engineering during this six years period does not give the right picture of the development for the product family. Therefore, it is more relevant to take a look at the total value of engineering resources used for the product family per year and divide that number by the total sales per year. The result is the average cost of engineering per unit sold, as displayed in the following figure.

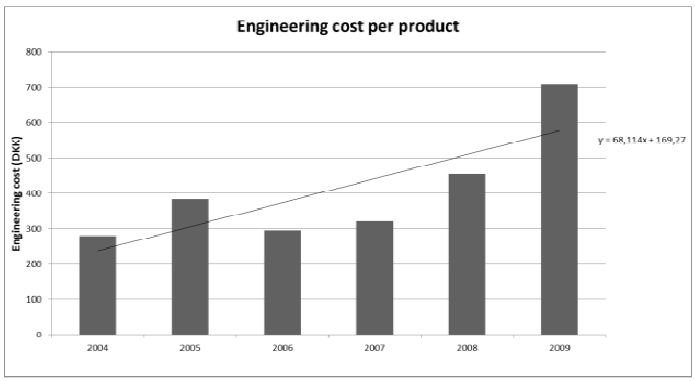

Figure 6.Engineering cost per piece

From these results, it is released that the engineering cost per product is increasing. This increase complements other data that show that the demand in specialized products is increasing through the years.

5.2.3 Sensitivity analysis

A sensitivity analysis is used to investigate the impact of different parameters. In this case study an important parameter to examine is the subsidiary mark-up. The sensitivity analysis explored how much it would mean for the company group in the course of five years if the subsidiary mark-up were 4%, 25 % or 35 %. The results are presented in the following table.

Table 1. Subsidiary mark-up

Year	2009	2008	2007	2006	2005
Sale	983	1400	1594	812	968
4,00%	-85	-895	-448	1306	673
4,51%	-36	-845	-374	1349	741
25,00%	598	-208	555	1920	1619
35,00%	922	118	1020	2223	2068

The negative numbers indicate that the subsidiary is delivering a deficit to the company. In this sense, the positive amounts show how much the company is earning on average on each sold unit. The subsidiary mark-up of 25% is the mark-up claimed by the head of the Netherlands subsidiary, backed up by sales personnel at the company.

5.3 **Analysis of market and competitors**

In this section the results from the competitors and the market analysis are presented.

5.3.1 Competitor analysis

Three main competitors, companies X, Y and Z, have been identified and analyzed. A comparison is made based on the characteristics of the competitive products resulting from the PVM attributes, such as product efficiency and weight, technical characteristics, delivery time and sale price. A part of the analysis is presented in the following table.

The competitor analysis shows that company X is the largest player in the market and has a wide variety of products. Company Y has a smaller turnover compared to the studied company, but the products that company Y mainly focuses on are the ones that are competitive to A, B and C. Efficiency, weight and delivery time are the parameters that the product family under examination lacks. The analysis results in pointing out that the company under investigation is the weakest one in the market. However, the main advantage of the company is flexibility and service, even to the extent of fulfilling customer´s needs even though they do not fit its standard product range.

Table 2. Competitor analysis

Comparison of efficiency and weight between company, X, Y, and Z					
	Static pressure [Pa]	Air flow [m3/s]	Efficiency [%]	Weight without motor [Kg]	Total list-price [Dkk]
A1	2700	10	81	604	105462
Similar product from X	2916	10	79	367	60950
	1808	8	81	461	66292
A2	1880	8	82	578	74773
A3	1880	8	82	718	103494
Similar product from X	1939	8	84	468	62010
Similar product from X	1916	8	82	320	44238
A4	778	21	68	1686	222924
Similar product from X	854	21	72	720	84387
A5	1693	21	74	1154	182811
Similar product from X	1854	21	83	720	102311
C1	516	10	54	187	34012
Similar product from X	369	10	51	320	37067
Similar product from X	467	10	86	720	70696
C2	2879	5	80	187	34012
Similar product from X	2847	5	81	*	29017
C3	3875	1	70	40	10420
Similar product from Y	4000	1	80	*	*
B1	1275	1	71	35	4399
B2	1275	1	75	40	8754
B3	1575	1	75	40	9215
Similar product from X	1430	1	81	27,5	5740
Similar product from X	1693	1	79	27,5	7966
Similar product from Y	1400	1	68	*	*
Similar product from Y	1700	1	52	*	*
C4	1691	8	80	187	34326
Similar product from X	1493	8	80	*	55513
C5	552	1	77	59	10314
C6	570	1	76	102	19751
Similar product from X	609	1	82	41	6823
Similar product from X	577	1	78	50	8951
B4	1421	2	69	98	13305
B5	1421	2	69	102	16238
B6	1421	2	78	121	24134
B7	1308	2	75	59	12329
Similar product from X	1424	2	75,5	34,2	6845
Similar product from X	1443	2	80,9	61	11457
C7	1691	8	80	187	34326
Similar product from X	1716	8	82	320	44238
Similar product from X	1649	8	78	*	35234
B8	921	2	72	89	9580
B9	921	2	72	98	12781
C8	921	2	80	84	14548
C9	880	2	77	102	20811
Similar product from Z	965	2	82,7	67,4	10374
Similar product from Z	967	2	81,4	91	13403
Similar product from Z	962	2	79,6	59	13759
B10	605	8	71	359	37667
B11	605	8	71	394	44713
Similar product from X	579	8	85,1	720	70696
Similar product from X	546	8	75	367	40368
Similar product from X	576	8	85,2	580	48918

5.3.2 Market analysis

The market analysis is performed on a country level and is presented in the following figures for products A, B, and C. Due to a lack of data to establish a coherent customer analysis, this section focuses on assessing market shares.

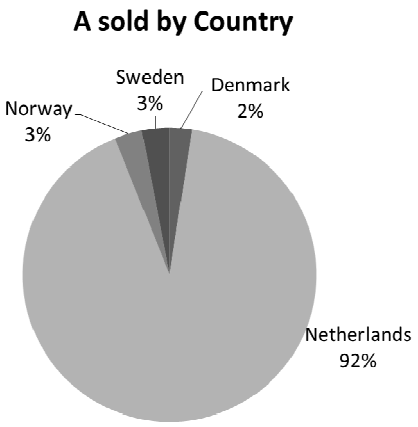

Figure 7. A products sold by country

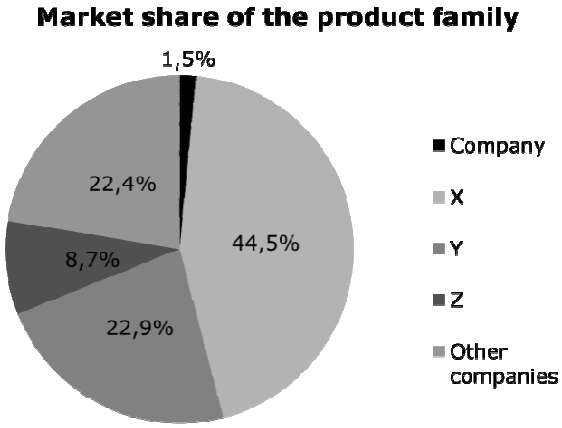

Figure 10. Market share

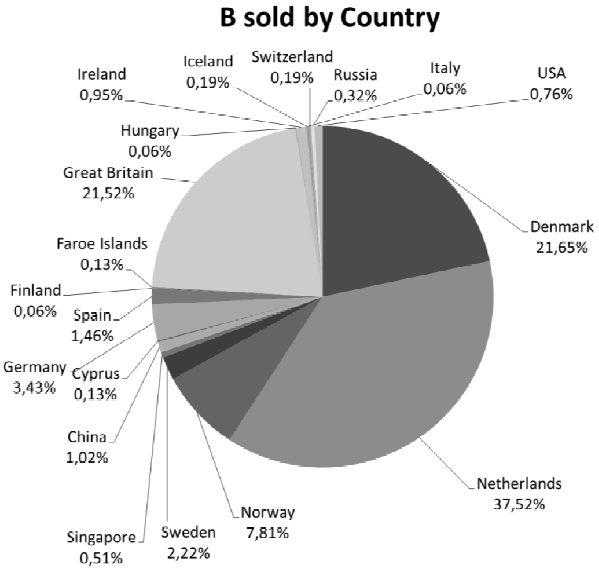

Figure 8. B products sold per country

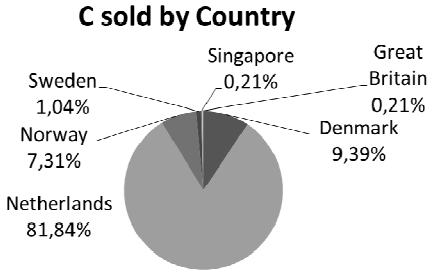

Figure 9.C products sold per country

It has been identified that although all three products are produced in Denmark, the percentage of their sales in Denmark is significantly lower than that in the Netherlands, where the main subsidiary is located.
Finally, the average estimated market share of the company and of its competitors is calculated and illustrated in the following figure. This results in a relatively low market share (1,5%) for the company for heating and ventilation products.

5.4 Scenarios for future product assortment

Although the product family has been redesigned following the principles of mass customization and standardization, there is a need for re-evaluation and further examination of the production set-up. As has been concluded from the previous two steps of the analysis, the company holds a relatively trivial market share compared to the competitors. In addition, the contribution margins of the three product families have been declining over the past six years. Based on these results, the development of the suggested scenarios focuses on overall cost reduction.
After assessing the results with the company's chief engineer some suggestions can be made. One possibility is to decrease the material use for parts of product A. Another would be standardizing components and decreasing the number of variants.

5.4.1 Decreasing the number of variants

From the PVM, it is identified that the fan is produced in four different positions, 0°, 90°, 180° and 270°. Each position has its own center height for each fan size. It can be seen from the information on the PVM that the center height for positions 90° and 180° is similar, and that positions 0° and 270° are closest to each other. Therefore, it is possible to have the same center heights for positions 90°and 180° and 0°and 270°. This means that the components connecting the fan house to the fan base can be decreased from 4 to 2, which results in decreasing complexity, both production- and assembly-wise.

5.4.2 Investment in a new machine

The plates for the variants produced at the company are cut with a laser cutter. After this operation, the remaining work required is welding. This operation for the product family under investigation is performed manually.
An investment in a robot welder is the second suggested scenario. However, such an investment of approximately 2.5 million DKK, is not affordable for the company. As a result the suggestion includes the robot welder to be used for all the product families produced by the company.

The total number of welding hours spent on manual work is calculated, along with the number of hours that will be saved by using the robot. The estimated annual cost reduction of the implementation of the robot welder is presented in the following table.

Table 3. Cost reduction by implementing the investment scenario

Investment in a new robot	
Initial investment (DKK)	2.500.000
Product family part	16,31%
Estimated cost reduction (DKK)	1.200.000
Investment ratio prod. fam. (DKK)	407.769
Cost reduction (DKK)	
A	51.917
B	31.563
C	37.532
Total cost reduction (DKK)	109.370

Based on the calculations the robot will be occupied for 16,31% of its time by the product family while the rest of the time will be used for the welding process of the other product families of the company. It can be seen from the table that the total cost reduction is not significant compared to the initial investment.

5.4.3 Stop the production

This scenario examines the benefits of stopping the production of the product family. There are two different options for the company in this case, either to sell the customer base or source similar products from competitors.
For the first option, it is required to estimate the future sales and sale values in order to calculate if this is an attractive solution for the possible buyers. This results in 1,25 million DKK earnings in the time horizon of five years for the potential customer. The following table summarizes the estimated earnings for the company when implementing the scenario of base selling.

Table 4. Company's side of NPV with sale with calculation rate of 11%

Year	Income (DKK)	Sales (DKK)		**NPV (DKK)**
0		4.741.300	4.741.300	**7.090.594**
1	521.543		521.543	
2	578.913		578.913	
3	642.593		642.593	
4	713.278		713.278	
5	791.739		791.739	

In order to explore and evaluate the second option, of outsourcing the product family, a comparison is made between the total cost of producing the products in-house, and the selling price for the competitors' products. Outsourcing is 19,2 % more costly for the company than producing its own products (73.301.165 DKK versus 61.479.904 DKK).

5.5 The final decision

The previous steps allowed the company to become ready to take a decision for the future product assortment. First, the product family has been analyzed, in terms of technical characteristics and profitability. Then, an analysis of the customers and the competitors has been performed in order to place the company in its market position. Finally, three scenarios have been created and benefits and costs of each scenario have been quantified.
At that point, the suggested scenarios are presented to the company as recommendations for the future product assortment strategy. Based on the results of the scenarios and the feedback received, after the scenarios have been presented to a workshop in the company, the most feasible solution is to stop the production. If the company decides on outsourcing the variants from the competitors, it would only increase the contribution margin if the company can get a discount on the products they purchase from competitors of at least 16%, based on the cost calculations. As a result, the most profitable solution was to sell the customers' base, which increases the company's income directly.

6. DISCUSSION AND FUTURE RESEARCH

The purpose of this paper is to build and test the suggested operational method for developing a product assortment strategy. Firstly, the relevant theories are used to build the conceptual framework of this research. The four step operational method attempts to guide a systematic approach of product scoping, profitability analysis for CTO products, customers and competitor analysis and scenario creation for future product assortment. It is a tool for assisting and coordinating the decision-making process of the product strategy in a company.
This work intents to contribute to the development of a structured and detailed approach to assessing the profitability of configurable products, including both economic and technical features of products, market aspects and competitors.
The application of the operational method to the case study reveals several options for the company's future and also valuable feedback for further research and extension of the research method. The applicability of both the operational method is tested and verified. Moreover, the challenges in data gathering have been identified. To this end, further research needs to be made in order to establish more explicit criteria for identifying and scoping potential product groups to analyze and to assess the suggested scenarios. Further research needs to done on how to assess the profitability of configured products based on configured modules with varying costs and variant sales prices for the final configured products.
Even though the studied case is considered to be highly representative of the CTO manufacturing context, the main limitation to the present test of the proposed

operational method is its generalizability. As there are results only from one case study, external validity can be challenged [43]. However, this case is considered to be an exploratory study in order to have an initial result from the application of the suggested operational method. Therefore, more cases have to be added to bring the present research further. This will enable not only identify possible additional limitations of the operational method, but also to improve and strengthen the structured approach.

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Upravljanje varijantnošću proizvoda konfigurisanih prema narudžbini – operaciona metoda

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Primljen (25.08.2014.); Recenziran (19.10.2014.); Prihvaćen (20.11.2014.)

Rezime

Kompanije koje proizvode kastomizovane proizvode teže da povećaju varijantnost svog proizvodnog programa u cilju ispunjavanja zahteva kupaca i usklade svoje strategije sa strategijama konkurencije. Međutim, profitabilnost proizvodnih familija može veoma varirati. Svrha ovog rada je da se razvije operaciona metoda za analizu profitabilnosti proizvoda konfigurisanih prema narudžbini kupaca. Operaciona metoda se sastoji iz četiri koraka: analiza asortimana proizvoda, analiza profitabilnosti konfigurisanih proizvoda, analiza tržišta i konkurenata i analiza scenarija asortimana proizvoda. Predloženi operaciona metoda je prvo razvijena na osnovu dostupne literature i iskustava u praksi, a zatim testirana u kompaniji koja proizvodi proizvode konfigurisane prema narudžbini kupaca. Rezultati iz ove analize su dalje diskutovani, a mogućnosti za dalja istraživanja identifikovane.

Ključne reči: *proizvodi konfigurisani prema narudžbini, operaciona metoda, varijantnost proizvoda, analiza profitabilnosti.*